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(54) **Apparatus for the administration of a respiratory gas and at least one anaesthetic**

(57) An apparatus (4) for the administration of a respiratory gas and at least one anaesthetic to a living being. The anaesthetic is vaporized in a vaporizing unit (34) by a respiratory gas and a safer and more accurate control of the anaesthetic concentration level is acquired in that an anaesthetic sensor (39) measures the concentration of the anaesthetic, a regulating valve controls the flow of respiratory gas through the vaporizing unit (34) and a regulating device (36) controls the regulating valve depending on a preselected concentration of vaporized anaesthetic in the respiratory gas and the measured concentration of anaesthetic in the respiratory gas. To further increase the control of the apparatus it may also be provided with a feedback system for both the temperature level in the vaporizing unit (34) and the total flow.

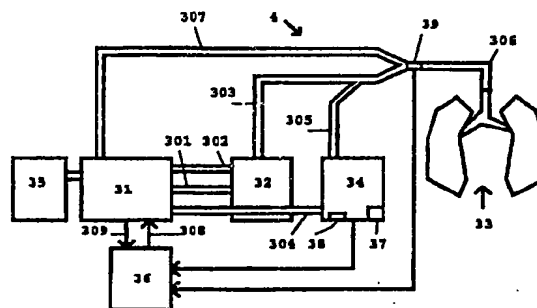


FIG. 3

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Description

The invention relates to an apparatus for the administration of a respiratory gas and at least one anaesthetic to a living being comprising a vaporizing unit which contains liquid anaesthetic, whereby a predetermined concentration of the anaesthetic in the respiratory gas is acquired by vaporizing a defined amount of the liquid anaesthetic in respiratory gas passed through the vaporizing unit, an entrance part via which the respiratory gas, or the gases that form the respiratory gas, is supplied to the apparatus and an inlet tube, which conducts the respiratory gas and the vaporized anaesthetic to the living being.

An apparatus of this kind is described in US-A-3,794,027. The apparatus, an animal anaesthesia machine, comprises a canister, to which a source of gas is connected via a vaporizer unit. An inlet tube conducts respiratory gas to a patient and an outlet tube conducts the respiratory gas from the patient via a common Y-piece. A second vaporizer unit is connected to the inlet tube. The two vaporizer units may be used separately or together and may contain the same or different anaesthetics. The first vaporizer unit comprises a valve, which can admit the gas from the gas source through the vaporizer unit or divert the gas around the vaporizer unit. When the gas is led through the vaporizer unit, it will bubble through the liquid anaesthetic and vaporize it. The gas containing the anaesthetic is then conducted to the canister and from there to the patient. The second vaporizer unit comprises two hollow sections which communicate via two apertures. The first hollow section forms a part of the inlet line. A substantially triangular vane can be placed in two positions, one of which permits the gas to only pass through the first hollow section. When the vane is brought into its second position, the gas will be led into the second hollow section and pass through a wick which separates the second hollow section into two halves. The wick is partially placed in the liquid anaesthetic and the gas passing through the wick vaporizes the liquid anaesthetic which has been absorbed by the wick. The gas containing anaesthetic then passes through the second aperture and out into the inlet line.

The control of the vaporization of the anaesthetic is, for both vaporizer units, performed manually by activating respective switch system (valve and vane) for a defined time when vaporization shall take place. The concentration of anaesthetic depends mainly on two factors: the gas flow through the vaporizer unit, which will determine the amount of anaesthetic that is vaporized for each time unit and the total time during which the gas is led through the vaporizer unit, which will determine the total amount of vaporized anaesthetic and thereby also the concentration. This results in a variation of the concentration during the time anaesthetic is supplied to the patient. In order to avoid concentrations that are too high or too low, an empirically established scheme for the switching on and off of the vaporizer unit should be fol-

lowed. With this system losses of anaesthetic from the system, through leakage and such, cannot be regarded.

Another known apparatus, described in US-A-4,770,168, comprises a chamber with liquid anaesthetic and a positive displacement pump. Via a valve gas can be diverted from a pipe to the chamber in which the gas becomes saturated with anaesthetic. The flow of gas from the chamber back to the pipe is controlled by the pump. By controlling the motor that drives the pump via a feedback system depending on a total flow in the pipe or the anaesthetic concentration in the pipe, the concentration of anaesthetic may be maintained with higher accuracy than the previously described apparatus. The chamber may also comprise a thermistor. The motor may then also be controlled depending on the temperature in the anaesthetic chamber.

However, the pump limits the useful range of the flow of anaesthetic saturated gas out into the pipe. This cause problems when a total flow is initially low, as is the case when small children or small animals are to be anaesthetized. Similar problems occur if the total flow is initially high. Furthermore, the required concentration level of anaesthetic may vary depending on the anaesthetic used and on the individual patient.

Yet another known apparatus is described in EP-A-166 305. The apparatus comprises a vaporizing unit where liquid anaesthetic is supplied to a gasifier to be vaporized. Through the gasifier flows a respiratory gas and carries the vaporized anaesthetic to a breathing circuit, to which a patient can be connected. The concentration of the anaesthetic is controlled by periodically, with a prescribed frequency and length of period, supplying liquid anaesthetic to the gasifier, i.e. similar to the control in the apparatus of US-A-3,794,027 described above.

An object of the invention is to provide an apparatus according to the first paragraph wherein the concentration of anaesthetic may be maintained with extremely high accuracy over a wide range of total respiratory gas flow.

This object is achieved in that the apparatus, according to the first paragraph, comprises a first sensor, located between the vaporizing unit and a living being, which measures the concentration of the vaporized anaesthetic in the respiratory gas and in that a regulating device controls the vaporization of the vaporizing unit depending on the measured concentration so that the amount of liquid anaesthetic being vaporized minimizes the difference between the predetermined and the measured concentration of anaesthetic in the respiratory gas.

By placing the first sensor after the vaporizing unit, preferably as close as possible to a living being, feedback the signal corresponding to the actual concentration and control the vaporization of the anaesthetic by means of a regulating device, a safe and advantageous control of the concentration of anaesthetic is obtained. Even a small deviation from a preselected concentration level brings about an increase or decrease of vaporization in the vaporizing unit. It is suitable to allow a deviation

of, for instance, 1% from the decided concentration level in order not to require continual infinitesimal adjustments.

There are basically three systems which can be used for administration of anaesthetic to a patient. First there is the non-rebreathing system in which all gases that are supplied to the patient are evacuated from the system after expiration. Then there is the semi-rebreathing system in which the anaesthetic is continuously recirculated to the patient while all other gases are evacuated. Finally, there is the rebreathing system, in which all gases, except expired carbon dioxide, are continuously recirculated to the patient.

The apparatus according to the invention may be used in all three systems.

For the apparatus there are three different advantageous types of vaporizing units. In the first the respiratory gas which is led to the vaporizing unit is led through the liquid anaesthetic. The respiratory gas which thereby becomes saturated with anaesthetic is then led through a connecting tube to the inlet tube where it mixes with the main flow of the respiratory gas before entering the living being. The regulating device controls the flow of respiratory gas led through the vaporizing unit. The distance between the connecting tube and the inlet tube and the first sensor should be large enough to allow a complete mixing of the gases before the concentration is measured. At the same time the distance should be as small as possible so that the regulating device may receive information about the actual concentration level as quickly as possible.

The second type of vaporizing unit comprises a throttle valve which causes a pressure on the liquid anaesthetic that forces an amount of the liquid to mix with the respiratory gas, whereby it vaporizes, and a connecting tube which leads the respiratory gas with the vaporized anaesthetic to the inlet tube. The pressure difference across the throttle valve is, for a constant respiratory gas flow, only dependent on the position of the throttle valve. The vaporization of liquid anaesthetic depends only on the pressure difference. An accurate adjusting of the position of the throttle valve, controlled by the regulating device, will therefore maintain the selected concentration level.

The third type of a vaporizing unit is obtained in that the vaporizing unit comprises a filter to which liquid anaesthetic is supplied, whereby the liquid anaesthetic is vaporized by the respiratory gas passing through the filter. Unlike to the second vaporizer unit according to the prior art description, in which the liquid anaesthetic was absorbed by a wick and vaporized by the respiratory gas flowing through the wick, in the third type of vaporizing unit it is possible to supply only the required amount of liquid anaesthetic to the filter. This provides for a very accurate regulation of the anaesthetic concentration level. Even if the respiratory gas flowing through the filter due to any kind of failure in the apparatus should increase, the vaporized amount of anaesthetic would remain constant. When supplying larger amounts of li-

quid anaesthetic to the filter it should be heated as the vaporization heat is taken from the filter itself.

In accordance with the invention there is a number of advantageous improvements in the apparatus, some of which being described below.

The apparatus is improved in that the vaporizing unit comprises a thermal control device which controls the temperature in the vaporizing unit and maintains it at a preselected level. As the saturation level depends on the temperature, the concentration can be maintained with even higher accuracy if the temperature in the vaporizing unit is kept at a constant temperature.

Alternatively this may be obtained in that the vaporizing unit comprises a thermistor for measuring the temperature in the vaporizing unit, in that the thermistor is connected to the regulating device, and in that the regulating device varies the flow of respiratory gas through the vaporizing unit depending on the measured temperature.

In order to, for the first two types of vaporizing units, further increase the accuracy only apart of the total respiratory gas flow is led through the vaporizing unit while the rest of the respiratory gas is conducted directly from the entrance part to the inlet tube.

With a flow sensor located in the inlet tube for measuring the total flow of respiratory gas, including the vaporized anaesthetic, the regulating system can be provided with a further parameter for increasing the accuracy. The flow sensor also provides for the possibility of controlling the total respiratory gas flow more accurately because the contribution to the flow of the vaporized anaesthetic can thereby be compensated for. To achieve this, the apparatus comprises a control unit which, depending on a measured flow, controls the entrance part so that the difference between the flow supplied to the living being and a preselected flow is minimized.

When an anaesthetized patient is to be awakened, or if an unwanted increase in the concentration of anaesthetic in spite of all precautions has occurred, it is an advantage to have a fresh gas tube connected to the inlet tube nearby the living being, through which fresh gas tube a respiratory gas or an additional gas may be supplied to the living being without first passing through the entrance part. The supply via the fresh gas tube is controlled by the regulating device so that the predetermined total flow is maintained. If the flow from the entrance part is replaced with a flow via the fresh gas tube, the concentration of anaesthetic is quickly reduced to 0%.

The safety of the apparatus is increased in that a control signal from the regulating device superimposes a basic signal corresponding to the selected concentration of the anaesthetic. Even if there should be a failure in one or several of the sensors or if the regulating device was to break down, the basic signal would still guarantee the maintenance of a concentration level of the anaesthetic that is harmless for patients connected to the apparatus. It is an advantage to use a microprocessor as regulating device.

In order to reduce the consumption of liquid anaesthetic it is an advantage to use a filter for the absorption and desorption of the anaesthetic. The filter is preferably located in the inlet tube. Such a filter, also known as a reflector, is described in WO88/07876 and is made of a material, which absorbs the anaesthetic during expiration and desorbs the anaesthetic during inspiration. When used together with a vaporizing filter, the two filters may be formed as one filter unit.

An alarm function for the concentration level is provided for in that a second sensor for measuring the concentration of the anaesthetic in the respiratory gas is located in the inlet tube, in the vicinity of the first sensor and in that a supervising unit gives an alarm if the anaesthetic concentration falls outside the predetermined interval around the preselected value. The completely separated alarm function increases the safety for the living being.

In connection with three figures, three embodiments of an apparatus in accordance with the invention are described, whereby

Fig. 1 shows a schematic block diagram of a first embodiment with the use of a semi-rebreathing system,

Fig. 2 shows a schematic block diagram of a second embodiment with a rebreathing system, and

Fig. 3 shows a schematic block diagram of a third embodiment with a non-rebreathing system.

Fig. 3 shows a non-rebreathing system apparatus 4 for the administration of a respiratory gas and an anaesthetic to a living being. In the non-rebreathing system neither the respiratory gas nor the anaesthetic is recirculated back to the patient after use, as is the case in a rebreathing or semirebreathing system which are respectively described below in connection with the figures 2 and 1.

An entrance part 31 supplies gas, for example oxygen and nitrous oxide, to a mixing unit 32 via a first oxygen tube 301 and a nitrous oxide tube 302. In the mixing unit 32 the gases are mixed before being conducted into an inlet tube 303 leading to a patient's lungs 33. A second oxygen tube 304 connects the entrance part 31 with a vaporizing unit 34. The oxygen flow to the vaporizing unit 34 is controlled by a regulating valve in the entrance part 31. In the vaporizing unit 34 liquid anaesthetic is vaporized by the oxygen flow and the oxygen becomes saturated with anaesthetic. Through a connecting tube 305 the saturated oxygen is conducted to the inlet tube 303 and mixed with the main flow of the respiratory gas before entering the lungs 33 through the patient tube 306. The patient tube 306 is common for both the inlet tube 303 and the outlet tube 307. Through the outlet tube 307 expired gas is led back to the entrance unit 31. The expired respiratory gas is then led to an absorber 35, in which anaesthetic is absorbed before the respiratory gas is evacuated.

An anaesthetic sensor 39 is located in the patient tube 306 for measuring the concentration of anaesthetic supplied to the patient's lungs 33. The anaesthetic sensor 39 is connected to a regulating device 36.

Each tube 301, 302, 304 has a regulating valve (not shown), all of the regulating valves being controlled by the regulating device 36. The regulating device 36 is connected to the entrance part 31 via a control line 308 and a signal line 309. Via the signal line 309 and the anaesthetic sensor 39 the regulating device 36 is provided with all information that is required in order to control the flow in each tube with highest possible accuracy, for example reference values of the flow, the position of each regulating valve, concentration of anaesthetic etc.

The vaporizing unit 34 comprises a thermal regulation device 37, which maintains a well-defined temperature in the vaporizing unit 34.

There are several different ways of saturating the oxygen which flows through the vaporizing unit 34 with anaesthetic. One way is to let the oxygen bubble through the liquid anaesthetic, another is to lead the oxygen through a wick soaked with liquid anaesthetic and a third is to lead the oxygen over the surface of the liquid anaesthetic, thereby continuously exchanging saturated oxygen with unsaturated oxygen, which will become saturated due to evaporation of liquid anaesthetic. As the saturation point is constant at constant temperatures a high accuracy for the concentration of anaesthetic in the total respiratory gas flow is obtained by controlling the flow through the vaporizing unit 34 accurately. The use of a feedback system provides an extremely exact control.

The vaporizing unit 34 may, as an alternative to the thermal regulating device 37, comprise a thermistor 38 connected to the regulating device 36, whereby the oxygen flow the vaporizing unit 36 is varied depending on fluctuations in the temperature as well as concentration of anaesthetic.

The apparatus 4 may also be provided with a further anaesthetic sensor as an extra safety precaution. If the concentration of anaesthetic, due to any possible reason, should increase or decrease too much, an alarm will be activated.

In fig. 1 a semi-rebreathing system apparatus 1 is described, i.e. the expired gas is not recirculated to the patient but conducted away from the patient except for the anaesthetic, which is recirculated.

An entrance part 10 supplies, via a nitrous oxide tube 101 and the first oxygen tube 102, a mixing unit 11 with oxygen and nitrous oxide. In the mixing unit 11 the two gases are mixed to form a respiratory gas which during inspiration is conducted to a patient's lungs 12 through an inlet tube 104. From the lungs 12 the respiratory gas is evacuated via an outlet tube 105 and the entrance part 10. When a patient is to be anaesthetized a vaporizing unit 13 is connected to the system. In the vaporizing unit 13 liquid anaesthetic, e.g. halothane, isoflurane or enflurane, is stored. By leading oxygen through the vaporizing unit 13, liquid anaesthetic is

vaporized and the oxygen is saturated with it. The vaporizing unit 13 is supplied with oxygen through a second oxygen tube 103. In the figure it is shown that the second oxygen tube 103 is led around the mixing unit 11, so that the oxygen will not be mixed with the other gases. From the vaporizing unit 13 the oxygen and the vaporized anaesthetic is conducted through a connecting tube 106 to a patient tube 107, which is common for the inlet tube 104 and the outlet tube 105 and in which the gas flow from the mixing unit 11 and the gas flow from the vaporizing unit 13 are mixed.

As anaesthetics are expensive and, furthermore, should not be allowed to come into the operating theatre where it may affect a surgeon, the apparatus 1 is provided with a filter 14 in the patient tube 107 which during expiration absorbs the anaesthetic in the expired gas and which during inspiration desorbs the anaesthetic to the respiratory gas. Such a filter 14, also known as a reflector, which will be used as designation henceforth, is described in WO88/07876.

An anaesthetic sensor 15, a flow sensor 16 and a second anaesthetic sensor 17 are located in the patient tube 107. The three sensors 15, 16, 17 are respectively connected to a regulating device 18 via an anaesthetic signal line 108, a flow signal line 109 and an alarm signal line 110. The regulating device 18 is connected to the entrance part 10 via a control line 111 and a first reference value line 112 through which a set value of the respiratory flow is transmitted, and to the vaporizing unit 13 via a second reference value line 113, by which a set value for the concentration of anaesthetic is transmitted. The second reference line 113 also connects the entrance part 10 to the vaporizing unit 13.

When a patient is to be anaesthetized a selected gas flow (litres/minute) and a selected relationship between oxygen and nitrous oxide is set on the entrance part 10 and a selected concentration level of anaesthetic is set on the vaporizing unit 13. The set values are transmitted to a microprocessor in the regulating unit 18 through the first reference value line 112 and second reference value line 113. The set concentration level of anaesthetic is also transmitted to a control device in the entrance part 10 via the second reference value line 113.

The control device of the entrance part 10 controls the valves which supplies the nitrous oxide tube 101 and the two oxygen tubes 102, 103 with gas. The control device hereby controls the valves so that the set respiratory gas flow is obtained with the selected mixture of oxygen and nitrous oxide. The valve which controls the flow through the second oxygen tube is set to supply an oxygen flow through the vaporizing unit 13, which is correlated to the selected concentration level of anaesthetic. As no anaesthetic has been absorbed by the reflector 14 at this point, i.e. at the beginning of the anaesthetization, a relatively large flow of oxygen is supplied to the vaporizing unit 13 in order to build up the concentration level. Via the anaesthetic sensor 15 and the flow sensor 16 the microprocessor of the regulating device 18 receives actual values of the concentration level and the respira-

tory flow. By comparing these values with the reference values a control signal is determined and via control line 111 transmitted to the entrance part 10. The determined control signal is superimposed on the control signal from the control device. A very accurate control of the set values is thus acquired at the same time as the apparatus 1 becomes relatively insusceptible to faults in the anaesthetic sensor 15 or in the microprocessor.

To compensate for the extra flow that the vaporized anaesthetic causes, the nitrous oxide flow is reduced to maintain the selected total respiratory gas flow. The reason for reducing the nitrous oxide and not the oxygen is of course that the selected oxygen concentration is more important to maintain. As an extra safety precaution the apparatus 1 comprises the second anaesthetic sensor 17, described above. Via the alarm signal line 110 actual values of the concentration level of the anaesthetic is transmitted to the regulating device 18. The regulating device 18 comprises an alarm unit, which is completely separated from the microprocessor and has the function of supervising the concentration level. If the level should fall outside a predetermined range, either lower or higher than the selected level, an alarm will be activated.

The apparatus 1 may also be equipped with a thermal control device 37 or thermistor 38 for increasing the accuracy.

Fig. 3 shows a rebreathing system apparatus in which the expired gas is purified from carbon dioxide in a carbon dioxide filter 20 located in the inlet tube 201. The inlet tube 201 forms half of a loop 200 in a patient unit 2 of the apparatus. Inspiration and expiration are controlled by a ventilating control unit 3 indicated in dot and dash lines. At the beginning of an anaesthetization the ventilating control unit 3 functions as the entrance part and supplies the patient unit 2 with respiratory gas. As the respiratory gas is recirculated, it is only necessary to supply additional gas to compensate for losses and to maintain the selected mixture of gases and level of concentration of anaesthetic. The second half of the loop 200 is formed by an outlet tube 202. As in the foregoing example a patient tube 203 is common for the inlet and outlet tubes 201, 202. In order to control the direction of the flow of the respiratory gas in the loop 200, the inlet tube 201 and the outlet tube 202 are provided with respective one-way valve 21, 22.

A vaporizing filter 23 is located in the inlet tube 201, through which the respiratory gas flows and thereby vaporizes the liquid anaesthetic which is squirted out into the vaporizing filter 23 from a vaporizing unit 24 via a vaporizing tube 204. An anaesthetic sensor 25 and a flow sensor 26 are respectively connected to a regulating device 27 via an anaesthetic signal line 210 and a flow signal line 211. The regulating device 27 can communicate with the ventilating control unit 3 via a two-way communication line 205, with the vaporizing unit 24 via a first control line 206 and with a fresh gas unit 28 via a second control line 207. The vaporizing unit 24 is connected to the regulating device 27 via a reference value line 208.

The fresh gas unit 28 is connected to the inlet tube 201 via a fresh gas tube 209 and allows fresh gas, e.g. oxygen, to be supplied to the inlet tube 201 to decrease the concentration level of anaesthetic in the respiratory gas. When awakening a patient it is preferable to quickly lower the concentration of anaesthetic. This is achieved by using the ventilating control unit 3 to empty loop 200 of respiratory gas containing anaesthetic while the vaporizing unit 24 is switched off and the fresh gas unit fills the loop 200 with fresh gas. The fresh gas unit may also supply oxygen to compensate for the uptake of oxygen by the patient. To increase the accuracy of maintenance of the oxygen level an oxygen sensor 29 is located in the inlet tube 201. Via an oxygen signal line 212 the oxygen sensor 29 is connected to the regulating device 27.

During use the patient unit 2 is first filled with the selected respiratory gas mixture by the ventilating control unit 3. Thereafter the ventilating control unit 3 controls the inspiration and expiration. During inspiration one-way valve 22 blocks the flow so that the respiratory gas is forced into the inlet tube 201, through the carbon dioxide filter 20 and the vaporizing filter 23. As in the foregoing example it is necessary to vaporize a larger amount of anaesthetic at the beginning of an anaesthesia, which in this case requires a relatively large amount of liquid anaesthetic to be squirted out into the vaporizing filter 23 via the vaporizing tube 204. To avoid a decrease in temperature, due to that the vaporizing heat being taken from the filter 23 itself, the filter 23 is heated during the vaporization. The heating also facilitates the vaporization. In the regulating device 27 the reference value, transmitted through the reference value line 208, and the actual value of the concentration level of anaesthetic, transmitted through the anaesthetic signal line 210, are compared. The supplying of a liquid anaesthetic is then controlled by the regulating device 27 depending on the reference value and the actual value. In the same way the oxygen content of the respiratory gas is controlled by comparing a reference value, transmitted to the regulating device 27 by the communication line 205, with an actual value, measured by the oxygen sensor 29, and supplying a sufficient amount of oxygen into the inlet tube 201. The respiratory gas, with its content of anaesthetic, then continues through the one-way valve 21, into the patient tube 203 down into the patient's lungs 30.

During expiration the one-way valve 21 prevents the respiratory gas from passing through the inlet line 201. The respiratory gas is therefore conducted through one-way valve 22 out into the outlet tube 202 towards the ventilating control unit 3. When an expiration is completed the flow will reverse to inspiration and the cycle starts anew.

Claims

1. Apparatus (1; 2, 3; 4) for the administration of a respiratory gas and at least one anaesthetic to a living

being (12; 30; 33) comprising a vaporizing unit (13; 23, 24; 34) which contains liquid anaesthetic, whereby a predetermined concentration of the anaesthetic in the respiratory gas is acquired by vaporizing a defined amount of the liquid anaesthetic in respiratory gas passed through the vaporizing unit (13; 23, 24; 34), an entrance part (10; 3; 31) via which the respiratory gas, or the gases that form the respiratory gas, is supplied to the apparatus (1; 2, 3; 4) and an inlet tube (107; 203; 306) which conducts the respiratory gas and the vaporized anaesthetic to the living being (12; 30; 33), characterized in that a first sensor (15; 25; 39) for measuring the concentration of the anaesthetic in the respiratory gas is located between the vaporizing unit (13; 23, 24; 34) and the living being (12; 30; 33), in that the first sensor (15; 25; 39) is connected to a regulating device (18; 27; 36) and in that the regulating device (18; 27; 36), depending on the measured concentration and the predetermined concentration, controls the vaporization in the vaporizing unit (13; 23, 24; 34) so that the amount of liquid anaesthetic that is vaporized minimizes the difference between the predetermined and the measured concentration of anaesthetic in the respiratory gas.

2. Apparatus according to claim 1, characterized in that the vaporizing unit (13; 34) comprises a thermal control device (38) which controls the temperature in the vaporizing unit (13; 34) and maintains it at a preselected level.
3. Apparatus according to claim 1, characterized in that the vaporizing unit (13; 34) comprises a thermistor (38) for measuring the temperature in the vaporizing unit (13; 34), in that the thermistor (38) is connected to the regulating device (18; 36), and in that the regulating device (18; 36) also controls the vaporization depending on the measured temperature.
4. Apparatus according to any of the preceding claims, characterized in that only a part of the total respiratory gas flow is led through the vaporizing unit (13; 34) and in that a connecting tube (106; 305) leads the respiratory gas containing the vaporized anaesthetic to the main respiratory gas flow in the inlet tube (107; 306).
5. Apparatus according to any of the preceding claims, characterized in that the vaporizing unit (13) comprises a throttle valve which causes a pressure on the anaesthetic liquid that forces an amount of the liquid to mix with a respiratory gas, whereby it vaporizes.
6. Apparatus according to any of the claims 1-4, characterized in that the vaporizing unit (23, 24) com-

prises a filter (23) to which anaesthetic liquid is supplied, whereby the liquid is vaporized by the respiratory gas passing through the filter (23).

7. Apparatus according to claim 6, characterized in that the filter (23) is located in the inlet tube (107) and in that the regulating device controls the supplying of liquid anaesthetic to the filter so that only a required amount of anaesthetic is supplied to the filter. 5 10
8. Apparatus according to claim 6 or 7, characterized in that a filter (14) for the absorption and desorption of the anaesthetic is located in the inlet tube (107). 15
9. Apparatus according to any of the preceding claims, characterized in that a flow sensor (16, 26) is located in the inlet tube (107, 201) to measure the total of respiratory gas and vaporized anaesthetic and in that the regulating device (18, 27) also controls the vaporization depending on the measured flow. 20
10. Apparatus according to claim 9, characterized in that a control unit depending on the measured flow controls the entrance part so that the difference between the flow supplied to the living being and a preselected value of the flow is minimized. 25
11. Apparatus according to any of the preceding claims, characterized in that a fresh gas tube (209) is connected to the inlet tube (201) in the vicinity of living being, through which fresh gas tube (209) a respiratory gas or any additional gas may be supplied to the living being without passing through the entrance part (3). 30 35
12. Apparatus according to any of the preceding claims, characterized in that a control signal from the regulating device (18; 27; 36) superimposes a basic signal corresponding to the preselected concentration of the anaesthetic, whereby the superimposed control signal increases the accuracy of the regulating valve. 40 45
13. Apparatus according to any of the preceding claims, characterized in that the regulating device is a microprocessor. 45
14. Apparatus according to any of the preceding claims, characterized in that a second sensor (17) for measuring the concentration of the anaesthetic in the respiratory gas is located in the inlet tube (107) in the vicinity of the first sensor (15) and in that a supervising unit gives an alarm if the anaesthetic concentration falls outside a predetermined interval around the preselected value. 50 55

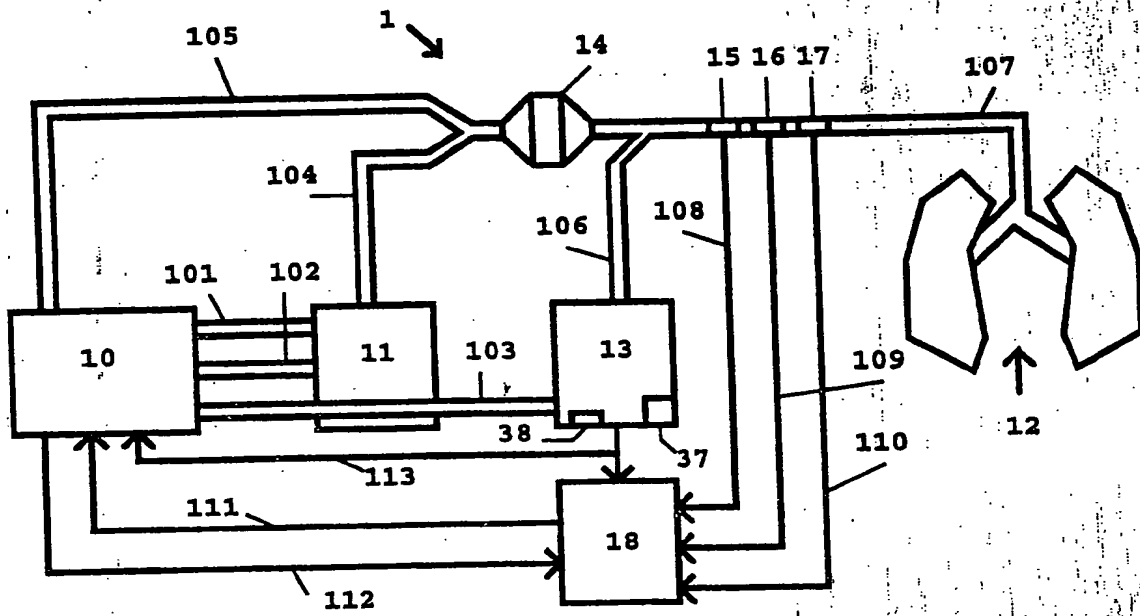


FIG. 1

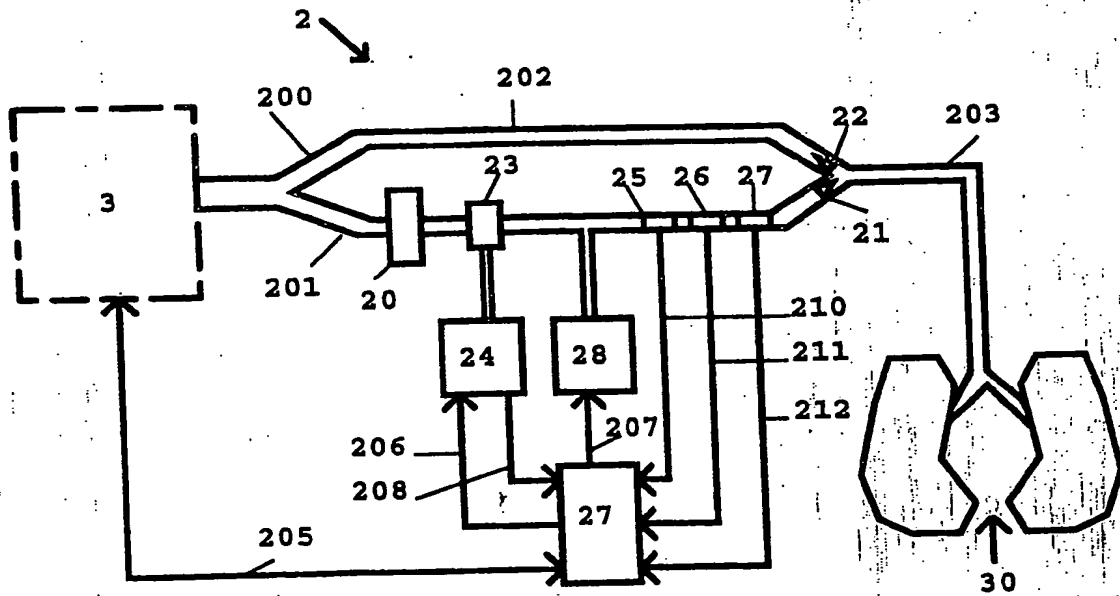


FIG. 2

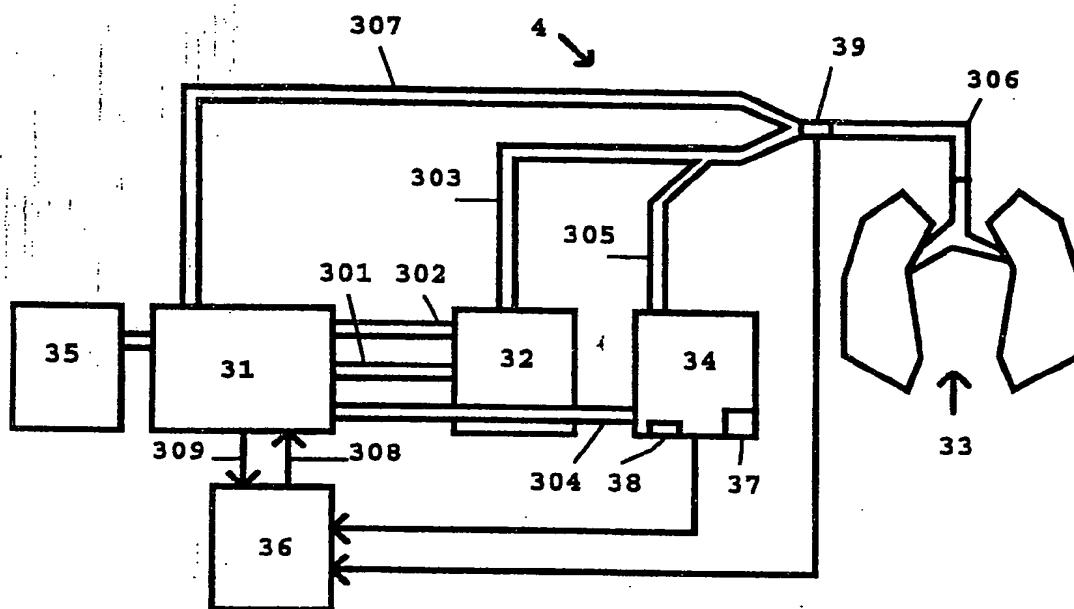


FIG. 3

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(54) Apparatus for the administration of a respiratory gas and at least one anaesthetic

(57) An apparatus (4) for the administration of a respiratory gas and at least one anaesthetic to a living being. The anaesthetic is vaporized in a vaporizing unit (34) by a respiratory gas and a safer and more accurate control of the anaesthetic concentration level is acquired in that an anaesthetic sensor (39) measures the concentration of the anaesthetic, a regulating valve controls the flow of respiratory gas through the vaporiz-

ing unit (34) and a regulating device (36) controls the regulating valve depending on a preselected concentration of vaporized anaesthetic in the respiratory gas and the measured concentration of anaesthetic in the respiratory gas. To further increase the control of the apparatus it may also be provided with a feedback system for both the temperature level in the vaporizing unit (34) and the total flow.

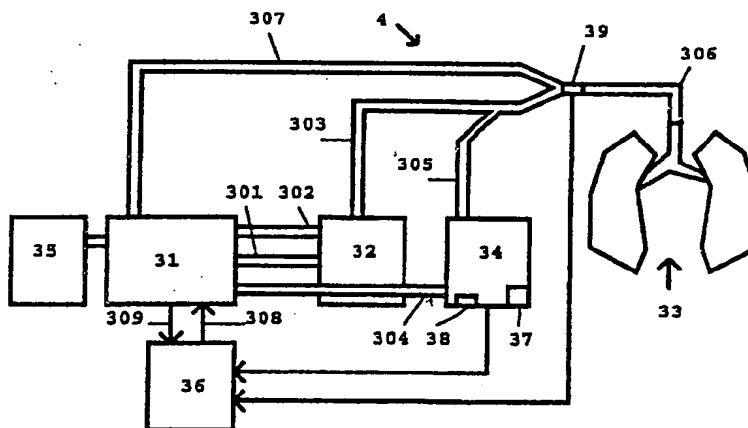


FIG. 3

EP 0 720 858 A3



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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.6)
A	US, A, 3794027 (JOHNSON), 26 February 1974 (26.02.74) --	1-14	A61M 16/01 A61M 16/12 A61M 16/18
A	US, A, 4770168 (RUSZ ET AL), 13 September 1988 (13.09.88) --	1-14	
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A	EP, A2, 0166305 (GAMBRO ENGSTRÖM AB), 2 January 1986 (02.01.86) --	1-14	
A	WO, A1, 8807876 (WERNER, OLOF), 20 October 1988 (20.10.88) -----	1-14	TECHNICAL FIELDS SEARCHED (Int. Cl.6) A61D A61M
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
STOCKHOLM		5 June 1996	NILSSON LENA
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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